RESEARCH PLAN

On

Proposed Ph.D. Research work entitled

"Study of Performance of the Signal Transmission through Fading Channels"

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I. INTRODUCTION

Radio-wave communications have experienced enormous growth over the last few decades. Most radio system transmits digital signals composed of binary digits. The important requirements by the system designers for fast and reliable communication are the knowledge of the date rate and the bit error rates. The parameters characterizing the data transmission depend on the methods of coding and modulation, channel characteristics, propagation environment and the methods of data recovery.

Two or more versions of the transmitted signal may arrive at the receiver at slightly different times. These waves combine at the receiver antenna to give a resultant signal that can vary widely in amplitude and phase, depending on the distribution of intensity and relative propagation time of the waves and the bandwidth of the transmitted signal. Multipath fading effect can be mitigated by some well known techniques; there are diversity in time, frequency and space, Space-Time codes, Multiple-input multiple-output (MIMO) etc. Various transmitter-receiver diversity techniques are used to increase the performance of system [1].

A method of combating the effects of fading is the use of diversity-combining of independently fading signal paths [2]. Some important combining techniques are the Selection Combining (SC), Maximum Ratio Combining (MRC), and Adaptive combining diversity (ACD) [3].

Various statistical models for fading of transmission have been proposed. Flat fading of narrowband transmission is often modeled by the stochastic distributions such as Rayleigh, Rice or Nakagami. For the channel that has a fixed line-of-sight (LOS) component and an indirect scattered component, the signal envelope has a Rician distribution of:

$$p_Z(z) = \frac{z}{\sigma^2} exp\left[\frac{-(z^2+s^2)}{2\sigma^2}\right] I_o\left(\frac{zs}{\sigma^2}\right), \qquad z \geq 0$$

where, $2\sigma^2$ is the average power in the non-LOS multipath components and $s^2 = \alpha_0^2$ is the power in the LOS component. The function I_0 is the modified Bessel function of zero th order.

Rayleigh fading model represents the fading in the special case when the channel has no LOS component, the signal envelope z(t) follows the Rayleigh distribution:

$$p_Z(z) = \frac{2z}{\overline{P}_r} exp\left[\frac{-z^2}{\overline{P}_r}\right] = \frac{z}{\sigma^2} exp\left[\frac{-z^2}{2\sigma^2}\right], z \geq 0$$

Another important stochastic distribution most often studied in this area is the Nakagami distribution, whose pdf is given by:

$$p_Z(z) = \frac{2m^m z^{2m-1}}{\Gamma(m)\overline{P}_r^m} exp\left[\frac{-mz^2}{\overline{P}_r}\right], \qquad m \geq 1/2$$

where $\overline{P_r}$ is the average received power and $\Gamma(.)$ is the gamma function. Nakagami and Rice distribution are closely related but the former gives simple expression for pdf and thus more tractable.

In a fast fading channel, the channel impulse response changes rapidly within the symbol duration. In other words, the coherence time of the channel is smaller than the symbol period of the transmitted signal. This causes frequency dispersion due to Doppler spreading, which leads to signal distortion. Condition for signal that undergoes fast fading is $T_s > T_c$ and $B_s < B_D$, where T_s is the reciprocal of bandwidth, T_c is coherence time, B_s is bandwidth and B_D is Doppler spread.

In a slow fading channel, the channel impulse response changes at a rate much slower than the transmitted baseband signal. The channel may be assumed to be static over one or several reciprocal bandwidth intervals. In the frequency domain, this implies that the Doppler spread of the channel is much less than the bandwidth of the baseband signals. Condition for signal that undergoes slow fading is $T_s << T_c$ and $B_s >> B_D$.

If the gain of channel is constant and linear phase response over a bandwidth that is smaller than the bandwidth of transmitted signal, then the channel creates frequency selective fading on the received signal. Under such conditions, the channel impulse response has a multipath delay spread which is greater than the reciprocal bandwidth of the transmitted message waveform. Frequency selective fading channels are also known as wideband channels since the bandwidth of the signal is wider than the bandwidth of the channel impulse response.

II. LITERATURE SURVEY

There are various well known bandwidth efficient modulations techniques used in wireless communications. These are M-ary amplitude shift keying (ASK), quadrature amplitude modulation (QAM), phase shift keying (PSK), rotated PSK. Bit error rate (BER) analysis of modulation techniques are important parameter [5]. There are a lot of coding techniques used for error detection and correction of the transmitted data. Performance analysis of forward error correction techniques is shown in this paper [6].The nature of the channel is time-varying due to rapid changes in the environment. Signal strength may drop by several orders of magnitude due to increase in distance between transmitter and receiver due to superposition phenomena in scattering environment. This is called fading and the channel is referred to as fading channels.

Some channels have constant gains and linear phase responses over a bandwidth that is greater than the bandwidth of the transmitted signal. Such multipath fading for narrowband case is referred to as flat fading. Performance of system with different modulation techniques over flat fading channel is discussed [7].

Multipath fading effect can be mitigating by some well known techniques, there are Diversity in time, frequency and space, Space-Time codes, Multiple-input multiple-output

(MIMO) [8] etc. Diversity-combining is based on the fact that independent signal paths have a low probability of deep fading simultaneously. Thus, the idea behind diversity is to send the same data over independent fading paths. These independent paths are combined in some way to mitigate the fading effect .different types of diversity techniques are Space diversity, Polarized diversity, Frequency diversity, and Time diversity.

Space diversity is method in which we use multiple transmit or receive antennas also called an antenna array, where the elements of the array are spatially separated [4, 9, 10]. In receiver space diversity, independent fading paths are realized without increasing transmit signal power or bandwidth. Coherent combining of the diversity signals leads to an increase in signal to noise (SNR) at the receiver over a single receive antenna system.

Time diversity is achieved by transmitting the same signal at different times, where the time difference is greater than the channel coherence time (the inverse of the channel Doppler spread). Time diversity does not require increased transmit power, but it does decrease the data rate since data is repeated in the diversity time slots rather than sending new data in these time slots. Time diversity can also be achieved through coding and interleaving.

In receiver diversity the independent fading paths associated with multiple receive antennas are combined to obtain a resultant signal that is then passed through a standard demodulator. In selection combining (SC), the combiner outputs the signal on the branch with the highest SNR. In contract, the maximum ratio combining, the output is the weighted sum of all the branches.

The combining method with the modulation and coding techniques enables fast and reliable communication even in the very hostile environment [11, 12].

There are different performance criteria commonly used to characterize the probability of symbol error such as outage probability and average error probability [13]. Data rate over Rayleigh fading channel with different coding schemes is also an important parameter of investigation [14].

III. OBJECTIVE: To Optimized the Performance of Wireless System in Fading Channel.

- To minimize probability of bit error.
- To minimize the required bit energy to noise power spectral density.
- To optimize the spectral efficiency of codes.

IV. METHODOLOGY

- An approach to study the spectral efficient digital modulation schemes (PSK, FSK, QAM, etc) with various coding techniques such as convolution, turbo etc, in multipath fading environment.
- To investigate the optimal data rate and opportunistic scheme using block interleaved over fading channel such as Rayleigh, Nakagami, etc.
- Proposed for the improvement in signal error rate (SER) with space diversity in Rayleigh fading channel.
- Study the different diversity techniques such as rotated modulation scheme.
- To find the optimum combining techniques with different modulation schemes in multipath fading.
- Investigate outage probability and bit error rate (BER) for MIMO relay including transmit antenna selection over Rayleigh fading channel.

Review of literature will be made in each of the above sections to streamline the actual research works. The work may not be confined to the above proposed areas only; recent trends in the areas will be followed up.

V. REFERENCES

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